

A Different Kind of Storm: Natech Events in Houston's Fenceline Communities

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Puffy plumes of steam rise from the Valero refinery in the Houston community of Manchester, merging into the cloudy August sky. An older Hispanic couple sit in their front yard just across from the refinery, eating their lunch, while two scientists sample the air and soil nearby. It is August 2020, one week after Category 4 Hurricane Laura veered right, sparing Houston, the “Energy Capital of the World,” from the devastation Hurricane Harvey wrought 3 years before. But the residents are perpetually in the path of a different kind of storm.

Garett Sansom, a research assistant professor of epidemiology at Texas A&M University (TAMU), is here with graduate student Leanne Fawkes. Working closely with local partner Texas Environmental Justice Advocacy Services, their goal is to find out what chemicals the residents of this community are exposed to and how exposures change before and after storm events. “Most of the visual stuff is steam,” Sansom says of Valero’s smokestacks. “It’s the invisible stuff that’s a problem.”

Manchester is one of several majority Hispanic and Black “fenceline” communities along the Houston Ship Channel, home to one-fourth of the world’s refining capacity.¹ Fenceline communities lie adjacent to industrial facilities and live with excess pollution levels, health disparities, and often lower-than-average incomes.² A history of redlining and segregation, along with a lack of zoning laws, has led many people of color to live in the shadow of industry.^{3,4,5}

Proximity to industrial neighbors puts fenceline communities in a double bind. They not only deal with daily exposure to potentially toxic emissions but also face increased risk of experiencing a so-called natech (“nay-teck”) event.⁶ Natech events—short for natural hazard–triggered technological disasters—occur when a natural occurrence such as a hurricane or flood leads to infrastructural failures such as a chemical spill or nuclear reactor meltdown.⁷ Experts interviewed for this story say neither government regulations nor companies’ planning documents are protecting public health from natech events.

The TAMU investigators frequently detect benzene—rare in a typical neighborhood—when they sample in Manchester. Today Fawkes gets a benzene reading of 0.036 ppm along with a total volatile organic compound (VOC) reading of 0.5 ppm. VOC levels rise and fall—these chemicals are volatile, after all—but 0.5 ppm “is weird in neighborhoods,” says Sansom.

Most of the available health data for benzene have come from occupational settings, Sansom says, where workers are typically healthy, have access to personal protective equipment, and stay on site for a maximum of 8 hours per workday. On the other hand, he says, “If you live in Manchester, you’re a child, and you’re exposed to it twenty-four seven, what does that mean? The truth is, there are no good toxicological models that can totally explain this situation.”



In the days following Hurricane Laura, Garrett Sansom and Leanne Fawkes of TAMU collected air and soil samples along the streets of Manchester, across the street from Valero’s Houston Refinery. TAMU investigators are working closely with local partner Texas Environmental Justice Advocacy Services to study chemical exposures in the community. All images: © Wendee Nicole.

Before Laura, chemical facilities in the Greater Houston area had released an estimated 4,400 tons of air pollutants⁸ beyond what their Clean Air Act permits allow during normal operations. Such “excess emissions” routinely occur as facilities shut down and start back up before and after major weather events.⁹ And during storms—whether a hurricane or Texas’s February 2021 historic winter storm—fenceline communities stand a greater chance of suffering the harmful consequences of a natech event due to their proximity.

Dealing with hazardous emissions and the fear of leaks and explosions are par for the course for Manchester and other fence-line neighborhoods.¹⁰ “Do we get scared sometimes? Of course we do. We live next to a refinery,” Cesareo Torres, the older man sitting in the front yard with his wife, says in Spanish. “But what are you going to do? We have a lifetime here. You kind of get acclimated to it.”

A Game-Changing Storm

Three years prior to Hurricane Laura, another historic storm hit the U.S. Gulf Coast and spawned numerous natech events. Hurricane Harvey was a game changer. The largest storm in U.S. history in terms of peak rainfall, the storm stalled over the Houston region, dumping 19 trillion gallons of rain.¹¹ The hurricane not only revealed vulnerabilities in community resilience¹² but also exposed how vulnerable coastal chemical infrastructure was and remains.¹³

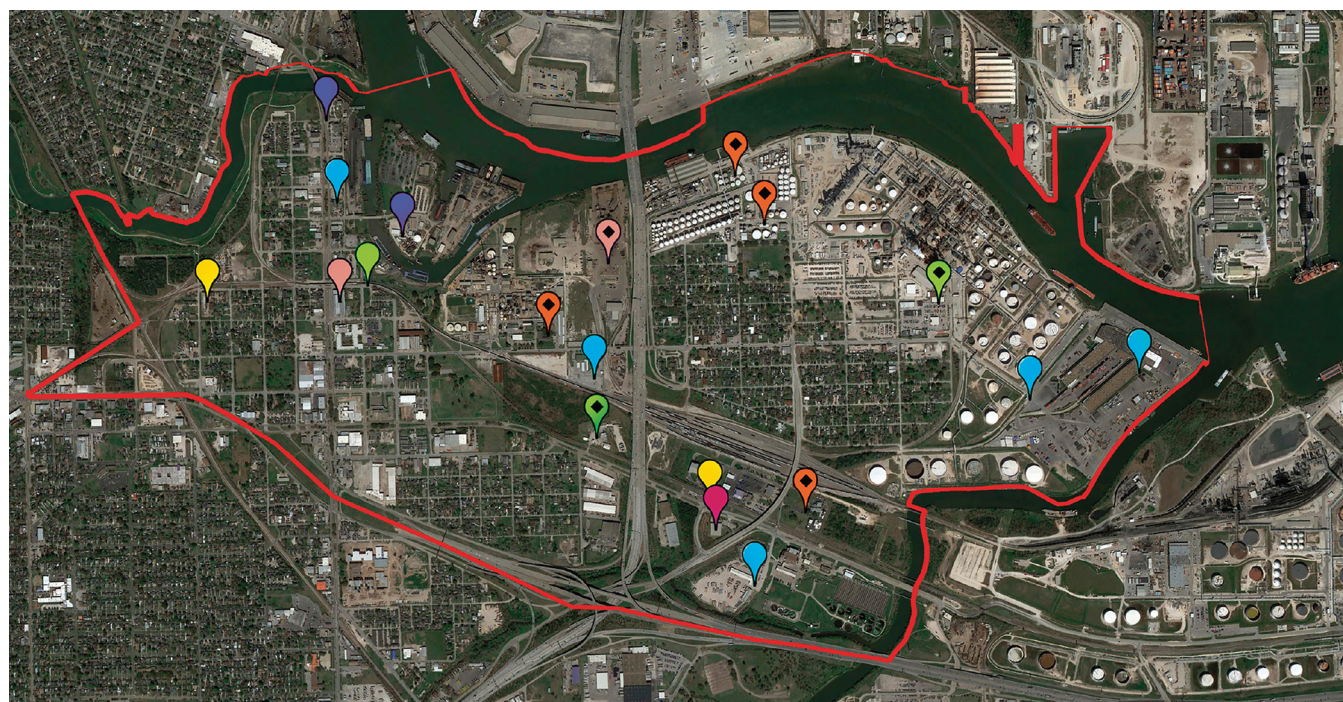
As floodwaters deluged 70% of the city,¹⁴ petrochemical chaos ensued. Facilities released an estimated 2,750–4,150 tons of excess emissions during shutdown and startup procedures.^{15,16}

Flooding caused additional substantial incidents.^{15,16,17} A storage tank failed at Valero, releasing 12.5 tons of air pollutants that included benzene, hexane, and toluene.¹⁸ Magellan Midstream spilled 461,000 gallons of gasoline near Galena Park,¹⁹ just across the ship channel from Manchester. ExxonMobil released 457 million gallons of untreated wastewater, including oil and grease mixed with stormwater, just upstream of Galveston Bay.²⁰ And an explosion at the Arkema chemical plant in Crosby burned for four days after a backup generator failed.²¹

A U.S. Environmental Protection Agency (EPA) Inspector General report¹⁸ on Hurricane Harvey concluded that neither state nor local authorities adequately monitored air quality during or immediately after the storm, nor did they effectively communicate with residents about the dozens of pollutant releases, spills, and explosions that resulted. Because natech events occur in the context of a primary disaster, the added layer of complexity is typically not accounted for in either company or governmental planning.¹⁸

For example, Arkema’s fiery explosion occurred due to catastrophic flooding, complicating the ability to manage the rapidly evolving situation: four feet of standing water made it nearly impossible to remove extremely reactive organic peroxides from harm’s way, only a “ride-out” crew remained on site, and Houston emergency responders were already overwhelmed with high-water rescues.²¹ People living near the plant inhaled smoke and were exposed to contaminated floodwaters as 115 tons of organic chemicals flowed into community streets.²²

According to a class action suit filed against Arkema after the storm, one couple were told by a National Guard member to evacuate their home. As the husband pushed a stalled motorcycle



Facility Type

■ Waste Disposal	■ Shipbuilding and Repair	◆ Required to Report Hazardous Releases (or Potential Risks of Release) to the EPA
■ Chemical Manufacturing and Storage	■ Petroleum Processing and Storage	— Manchester Community Boundary
■ Shipping	■ Industrial Supplies	
■ Metal Manufacturing and Recycling		

One of several fenceline communities along the Houston Ship Channel, Manchester is home to 19 facilities representing numerous industries. However, only 7 of these facilities are required to report potential or actual hazardous releases to the U.S. EPA—the others do not reach the reporting threshold set by the agency, although they are very likely emitting hazardous pollutants. Image: Courtesy Union of Concerned Scientists.



Companies along the Houston Ship Channel battened down their hatches as Hurricane Harvey pushed floodwaters ever higher on 27 August 2017. The storm would go on to cause a multitude of structural failures, explosions, spills, and other natech events. Image: © Thomas Shea/AFP via Getty Images.

through floodwater, “his legs began to burn, [and] he cried out in pain but kept pushing the motorcycle, imploring his wife to continue to keep her legs out of the water.” The man was left with persistent “blisters, lesions, and burns” on his legs. Reportedly, neither the National Guard member nor the couple were told of the contaminated floodwaters.²³

After investigating the Arkema incident, the U.S. Chemical Safety and Hazard Investigation Board (CSB), a government entity, found “a significant lack of industry guidance on planning for flooding or other severe weather events, such as lightning strikes, earthquakes, and high winds.”²¹ The CSB concluded that the Arkema incident was not an anomaly: In all, 102 Harvey-related incidents were reported to the U.S. Coast Guard National Response Center, fewer than half of which occurred as part of shutdown or startup operations.²¹

Separately, legal experts analyzing Arkema’s explosion noted substantial failures in both the regulation of hazardous materials and the emergency planning conducted around the Hurricane Harvey response²² and reiterated that standard industry hurricane preparation protocols have proven inadequate for containing natech events.²⁴ Both the U.S. EPA Inspector General and CSB concluded that, while the scope of Harvey was unprecedented, much of what happened during the hurricane could have been averted.^{18,21}

Is the Chemical Industry Adapting?

As climate change increases the likelihood of intense storms, experts predict an increase in natech events—posing a great risk not only to human health but also to the economy and business interests.²⁵ By now, nearly four years after Hurricane Harvey, one might expect to hear that industry is making major changes to better protect both public health and companies’ infrastructure from climate-accelerated disasters. But such information is hard to come by.

In the 2020 report “In the Path of Destruction: Preparing for Climate Change in the Chemical Industry,”²⁶ analysts at the consultancy Lux Research mined voluntary reports to the nonprofit CDP (formerly the Carbon Disclosure Project) about how companies view climate risks and what they are doing about them. CDP runs a voluntary disclosure system for companies, cities, states, and regions that, in the nonprofit’s words, “fuels and tracks global progress toward building a sustainable economy.”²⁶

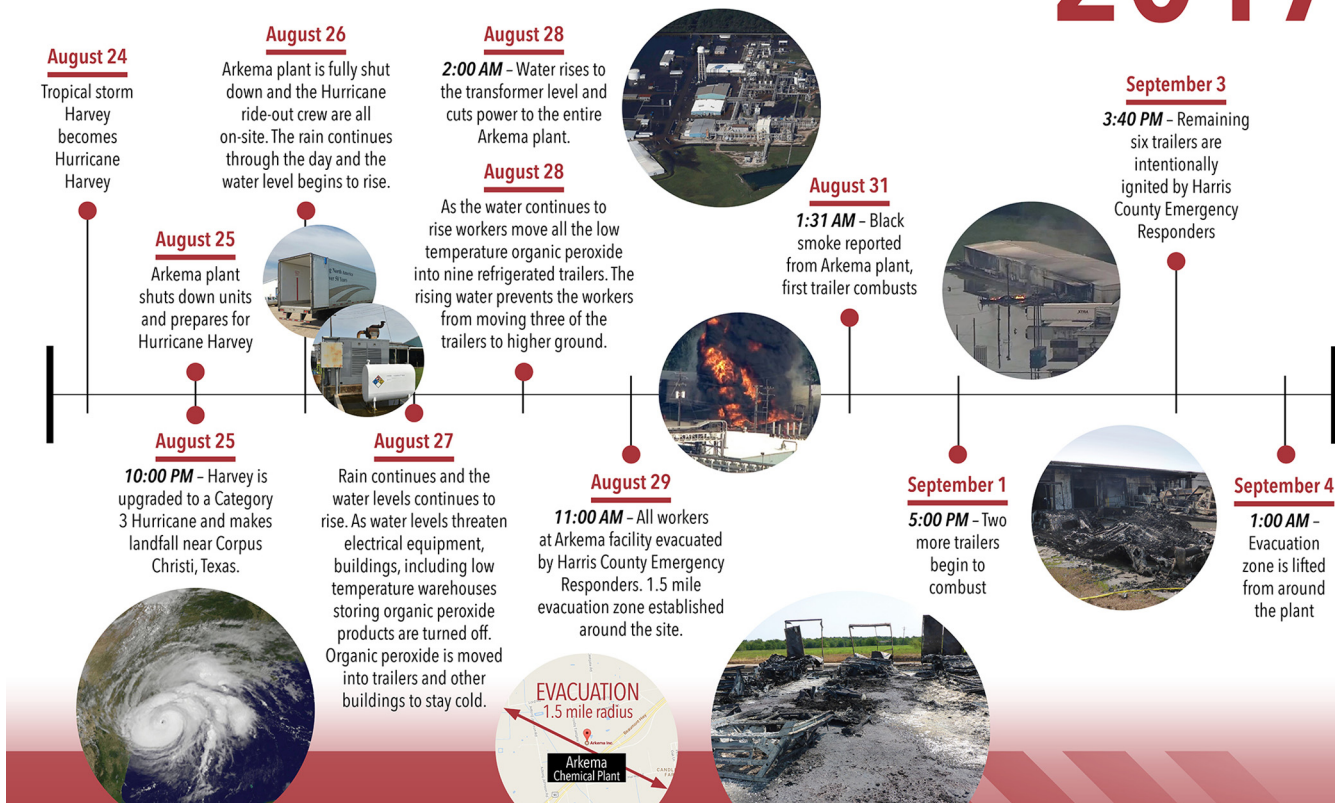
Lux’s analysis found that, by and large, the companies they assessed were measuring risk in the future. Prepping for climate change “didn’t seem as good of an investment because [companies] thought of climate change being ten years down the road, not something happening today,” says coauthor Kristin Marshall. This means they will continue to be unprepared for upcoming natech events unless they take action.

Cross checking records from the CDP²⁷ and the Texas Commission on Environmental Quality²⁸ indicates that only 4 of the 24 companies reporting excess Hurricane Harvey-related emissions also reported to CDP about their climate preparations: Arkema, Dow Chemical, Formosa, and LyondellBasell. In Arkema’s 2020 CDP report²⁹ (available with free registration on the CDP site), the company explicitly acknowledged that climate change brings increased acute physical risks to its facilities from storms, droughts, and floods, as well as financial and legal risks. The company linked the Harvey-related explosion and subsequent lawsuit with climate change and stated it will “ensure periodic assessment of the potential impact of a natural disaster or extreme weather event at its sites.”²⁹ The company also reported it had developed a planning and response toolbox to ensure that backup power and other safeguards continue to function during extreme weather.

The American Chemistry Council hosted industry and government officials at a day-long forum in Houston following Hurricane Harvey.³⁰ According to spokeswoman Jenny Heumann,



Timeline Related to Arkema Inc. Chemical Plant Fires 2017



Arkema produces organic peroxides that are used in a variety of consumer products. Some of these chemicals must be stored at low temperatures. With Hurricane Harvey's floodwaters rising, workers began powering down parts of Arkema's Crosby facility; when it became clear the water was not stopping, the ride-out crew frantically worked to secure the unstable organic peroxides in refrigerated trailers. Despite heroic efforts, the chemicals in three of the trailers decomposed and ignited. The remaining trailers were ignited in a controlled burn. Altogether, 175 tons of organic peroxides burned. Both images: Courtesy U.S. Chemical Safety Board.

the officials developed emergency preparedness recommendations for the chemical industry on the Gulf Coast, including using technologies and information technology systems (such as digital apps) to locate and communicate with employees, employing drones to assess facilities, updating hurricane plans for more severe weather conditions, and better communicating with community members and emergency planners.

A few companies have embraced such innovations, although they focus more on employee safety than protecting public health or nearby communities. Anthony Schiavo, senior analyst at Lux Research, gives a hat tip to Dow Chemical, which he says has invested in using conventional drones for imaging and surveying sites and customized robotics designed to enter small spaces. “Hurricane Harvey was a bit of a wake-up call, and there has been a response to that on a certain level,” says Schiavo. “However, I think part of what our report²⁶ concluded is that a lot of what has been done isn’t really sufficient—especially looking forward.”

Most companies focus more on perceived negative financial impacts of climate regulation than on being in the path of a hurricane or flood, according to Anton Rushakov, a senior consultant at Global Affairs Associates and author of the 2020 report “Gathering Momentum: Climate-Related Reporting by Fortune 500® Companies in Texas.”³¹ In a webinar³² discussing the report, Rushakov said, “In the energy sector, the main focus is on regulatory risks and specifically on potentially increased cost of compliance with more restrictive greenhouse gas regulations, and physical risks are seen [as] ... more long-term risks rather than something that companies have to deal with right now.”

Some analysts think the petrochemical industry will eventually move away from this region altogether. “Between the higher cost of doing business in the Gulf Coast region because of climate change as well as the macroeconomic changes to demand for oil,” Schiavo says, “we think there’s long-term pressure that makes operating in the Gulf Coast not as attractive in the future.” He adds, “Trying to mitigate the actual damage from climate change is just not going to be sufficient. The way to mitigate this is to get out of the path of destruction.... Physically moving the infrastructure is important.”

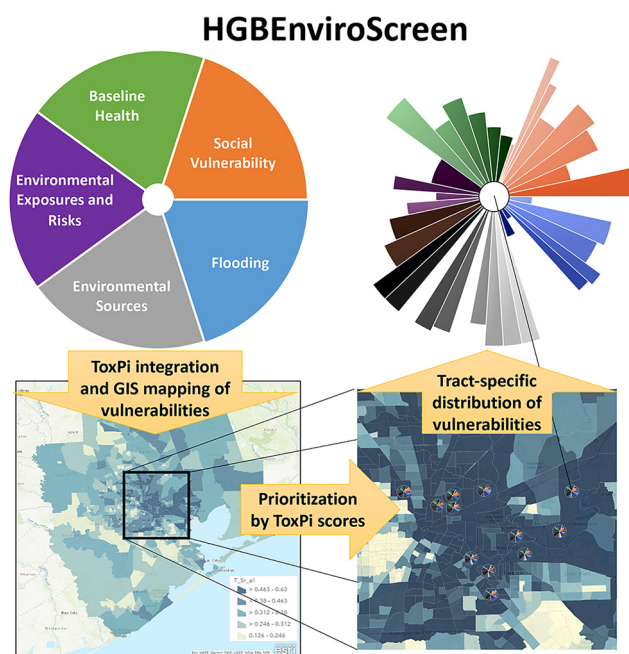
That may be good news for Houston’s fenceline communities in the long term. In the short term, however, they continue to face health disparities, ongoing recovery from past flooding, and fear of future disasters, with little recourse.^{34,35}

Scientists Addressing Environmental Disparities

No matter how acute the health concerns, the fear, or the determination, individual community members—even when joined together—often lack the scientific data or political clout to advocate effectively against the inequities they face. A loose collaboration between the National Institute of Environmental Health Sciences–funded Superfund Research Center at TAMU, several local community-based organizations, and the Environmental Defense Fund (EDF) is aimed at changing that.

“If you want to improve your situation or advocate for change, where do you focus your efforts?” says Weihsueh Chiu, a professor in the TAMU Department of Veterinary Integrative Biosciences who is part of the Superfund Center project. “You’re in a red zone, but what’s the most effective way to try to mitigate that?”

After Harvey, EDF scientists approached Chiu about developing a tool to help communities better understand their vulnerabilities, improve their resilience, and advocate for change. Having worked at the U.S. EPA for many years, Chiu was inspired by the agency’s EJSCREEN tool,³⁶ which maps environmental injustice hot spots nationwide. He led the charge to develop a modified version specifically for the eight-county Houston–Galveston–Brazoria region. The tool, known as HGBEnviroScreen,³³



The HGBEnviroScreen tool, developed by TAMU investigators, quantifies and visualizes the constellation of vulnerabilities within a community. Image: Bhandari et al. (2020).³³

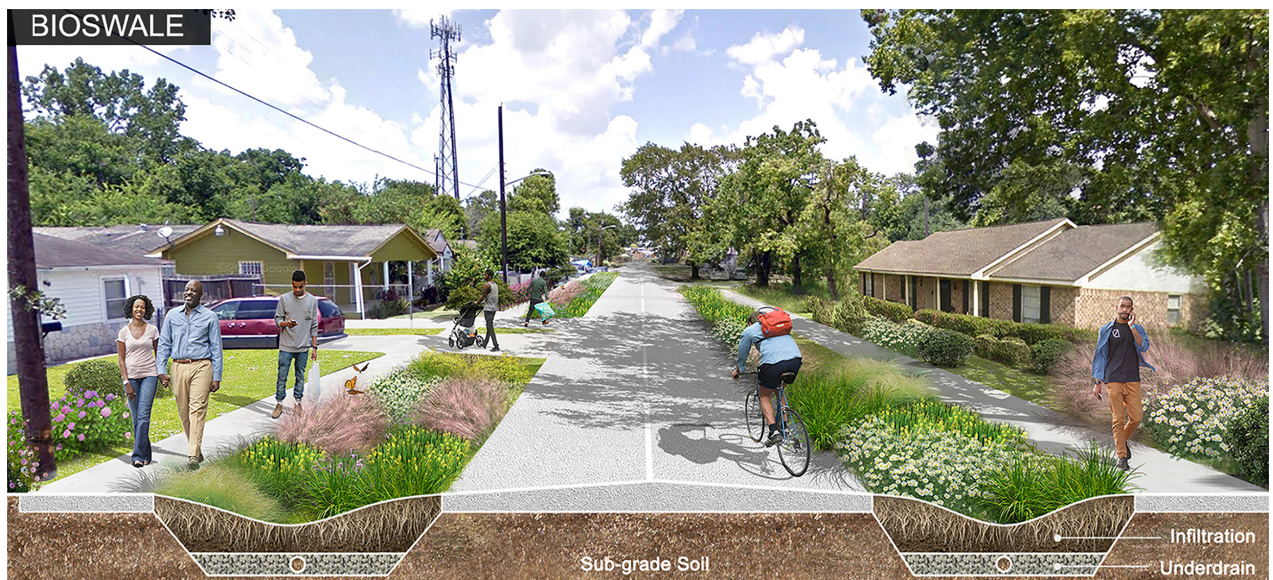
visually represents community vulnerabilities using charts produced using ToxPi software.³⁷

“ToxPis were originally [used] just to evaluate individual chemicals, but we thought maybe we could apply that geospatially,” says Chiu. Combining ToxPis with ArcGIS mapping software, Chiu and colleagues plotted data from 1,090 census tracts in the region to analyze vulnerabilities after Harvey and also more generally.³³ Community data were categorized as social vulnerabilities, baseline health, pollution sources, flooding, and—in a category that captures vulnerability to a natech event—exposures and risks.

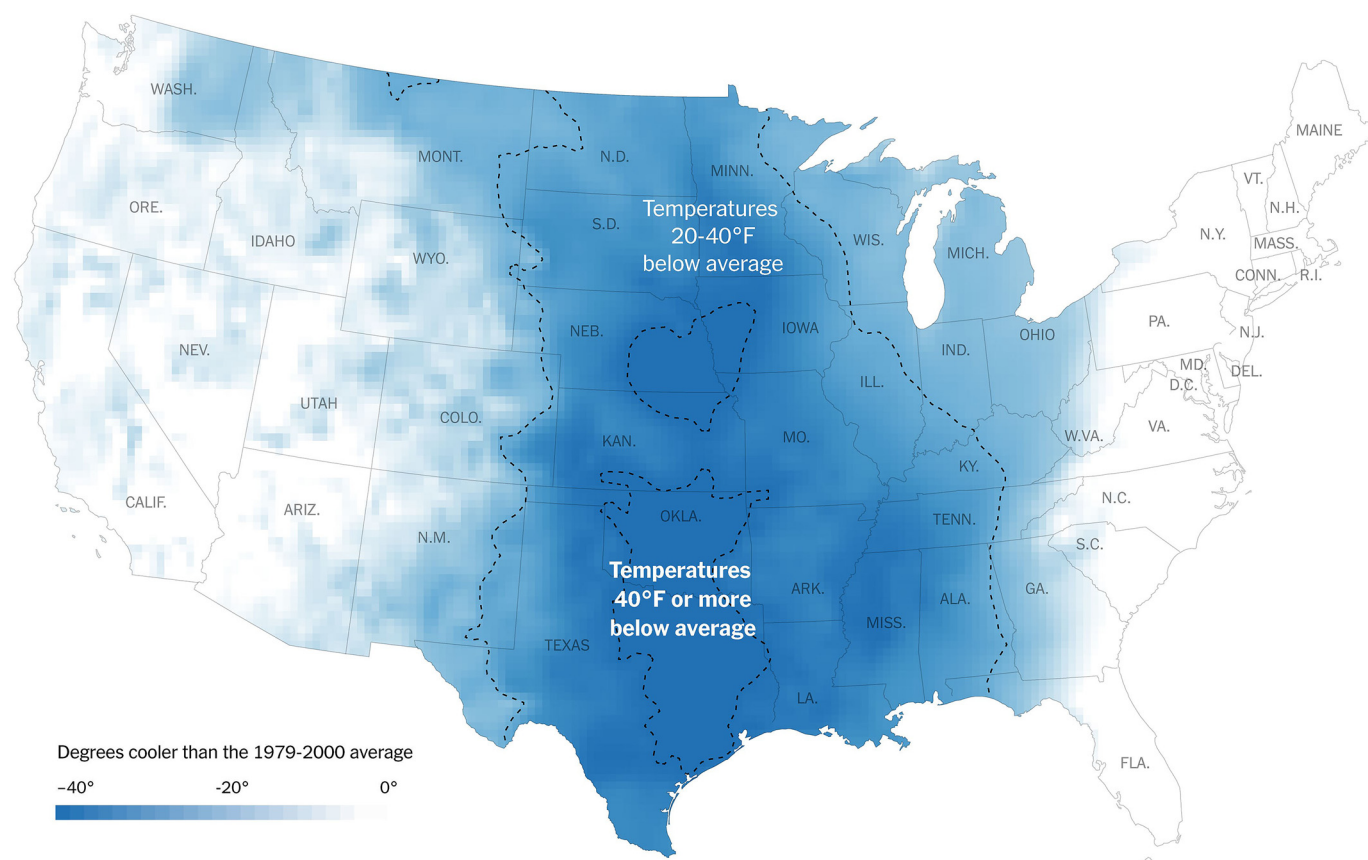
After data were gathered and the ToxPis generated, Superfund Center researchers met with community members (other planned meetings have been delayed due to the COVID-19 pandemic). The investigators found that Manchester’s main vulnerabilities were proximity to a petrochemical facility, low socioeconomic status, health disparities, high flood risk, and the chance of a plant explosion or major chemical leak—not to mention daily exposures to polluted air. The HGBEnviroScreen results quantify these vulnerabilities and give the residents the vocabulary to more effectively address the injustices they face with local and state legislators and policy makers.

In a parallel project, EDF is working with local partners through a project called Data to Action, says collaborator Grace Tee Lewis, an environmental health scientist at the organization. “Data to Action is meant to support these community-based organizations in their efforts to address longstanding environmental and health disparities that make them particularly vulnerable,” she says. The goal is for residents to create community action plans that can be leveraged to lobby governments for policy changes, apply for funding for projects, or otherwise make positive changes in their neighborhoods.

Manchester is part of the City of Houston’s Complete Communities Initiative, an effort to help revitalize lower-income neighborhoods.³⁸ Home buyouts have occurred here as one solution to reducing flooding and pollution risk; such homes are usually demolished and turned into greenspace.³⁹ But two months before Hurricane Harvey, the cash-strapped city sold two Manchester streets to Valero.⁴⁰ Sansom says the facility is expanding its operations into that area.



Caption appears on the next page



While hurricanes may be the most common type of extreme weather to affect Gulf Coast residents, February 2021 brought a whole new challenge: temperatures that plunged below freezing, crashing the electrical grid and leaving millions of people without electricity.^{43,44} Dubbed Winter Storm Uri by the National Weather Service, the polar air brought snow, freezing rain, ice, and record-low temperatures for which neither homes nor chemical facilities were adapted. A sudden loss of electricity left some industrial facilities in a lurch, requiring emergency shutdown and startup procedures that caused excess emissions—3.5 million pounds from 200 Texas facilities over a 12-day period, according to one unpublished estimate.⁴⁵ In Manchester, the Valero refinery released more than 44,500 pounds of excess emissions including carbon monoxide, hydrogen sulfide, ammonia, and sulfur dioxide.⁴⁶ Image: © *The New York Times*.

Taking Matters into Their Own Hands

Residents of Galena Park are also taking matters into their own hands. Cruz Hinojosa, president of Environmental Community Advocates of Galena Park (ECAGP), worked with EDF to develop an action plan to help the community address persistent pollution, flooding, and other issues. They convinced authorities to provide Spanish-language versions of the ever-present emergency alerts issued for nearby chemical plants. “The other thing we wanted to do,” Hinojosa says, “is educate, educate, educate.”

“A lot of people, they know there’s some plants there. They might know the chemicals, but they don’t know how bad they are,” says Juan Flores, ECAGP’s vice president. “Then, even when stuff happens with the fires or emissions or there’s an oil spill, people get all hyped up about it, like, ‘we need to do something.’ But then when it comes down to it, people back off because somebody works for the refineries, a family member does, and they don’t want to say anything because they’re scared.”

Flores grew up in Galena Park and used to play on the large grassy hill created from ship channel dredge spoils. “Me and my friends, we used to go up there, take our bicycles and play in it. There was quicksand up there. You would sink halfway, and

we’d pull each other out,” he says. “You’d see water up there that was multicolored. We called it rainbow water. We didn’t know about pollution when I was a kid, so we’d play in it.”

Building on past work by the scientists, EDF, and their community partners, the U.S. EPA recently awarded TAMU an \$800,000 Science to Achieve Results grant to help Galena Park build resilience to excess pollution and flooding.⁴¹ Superfund Center investigators will identify nonchemical stressors in the community and assess their relationship to residents’ vulnerability to pollution-related health impacts. They will also explore structural and nonstructural solutions for mitigating flood risks, such as reducing the amount of impervious surface area or installing green infrastructure, such as constructed wetlands, bioswales, or rooftop gardens.

“We use community engagement to try to come up with design solutions with a focus around flood resilience,” says Galen Newman, a TAMU professor of landscape architecture and urban planning who is part of the Superfund Center team. He has worked in Manchester as well as Sunnyside and South Park, predominantly Black neighborhoods. “Once a final plan is agreed on, we do performance modeling [to determine] how much it

Caption from preceding page

TAMU Superfund Center investigators have proposed a variety of nature-based solutions to help Galena Park mitigate flood risks. Bioswales are vegetated ditches that absorb and channel stormwater, whereas rain gardens receive and soak up excess runoff. Detention ponds collect stormwater and store it as it slowly drains out an outlet in the bottom of the basin. (Retention ponds, by comparison, contain water all the time.) All images: Courtesy Rui Zhu and Galen Newman/Texas A&M University.

costs to put in green infrastructure, the annual benefits, how long it will take for it to pay off, how much water it holds, and how much impervious surface area is decreasing.”

With the data talking—including fiscal data—fenceline communities can help their elected and appointed officials see a path to minimizing risks and improving future health outcomes. However, although communities can use scientific findings to advocate for themselves—and that has been the goal of these innovative multidisciplinary projects—experts emphasize that it is important not to place the burden for change on already-vulnerable underserved communities.

Although science can certainly help communities prove their points, what the residents can do with that information is still limited—and that goes for a universe of health hazards far beyond natech events. “When you present them with ‘here’s what you can do to prevent exposure or health risk,’ that’s all good as long as it’s within the means of the community,” says Sansom. “For example, we found detectable lead levels in [Manchester] homes,⁴² and it’s just not within their means to retrofit their pipes. Solutions have to come from industry or at the state or federal level to have any kind of meaningful impact.”

Houston resident **Wendee Nicole** visited Manchester and Galena Park when reporting this story. She also visited Manchester in the days immediately following Hurricane Harvey.

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